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CONSERVATION AND USE OF WATERS IN THE RECLAMATION OF ARID LANDS THROUGH GOVERNMENTAL AGENCIES

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Under the terms of the so-called Newlands Act of June 17, 1902, the United States has invested upwards of $70,000,000 in the building of reservoirs for the storage of flood waters and in canals and related structures for taking these and other available waters to lands which in their natural condition have such a small supply of moisture that valuable crops cannot be obtained each year.

The moneys for this purpose are obtained from the disposal of portions of the public domain, and as the lands are disposed of the moneys received are put into a fund in the Treasury. These moneys are then expendable under the direction of the Secretary of the Interior in his construction of the works above mentioned. When these works are completed to a point where water can be brought to the lands, these latter, if in public ownership, are opened under the terms of the Homestead Act in tracts of not more than 160 acres in extent, the size being limited by the area which in the opinion of the Secretary of the Interior will be sufficient for the support of a family. This averages about 40 acres. In some cases it is as small as 10 acres.

The public lands thus reclaimed are given away on condition that they are cultivated and actual residence established and maintained during five years. The estimated cost of bringing the water to the land, including the construction of the reservoirs and all administrative and relative charges, must be repaid by the homesteaders or by those purchasing private lands to which the water may be brought. The payment is made in annual instalments not exceeding ten; for example, if the cost of storing and bringing the water to the land has averaged $30 per acre, the homestead entryman or purchaser of the land is required to pay $3 per acre per annum for ten years. The amount thus received goes immediately into the Reclamation Fund and can be expended at once without further act of appropriation. Thus the Reclamation Fund is what has been termed a revolving one, being continually returned. At the same time it is being increased in amount by the additions from the disposal of other lands not taken up under the terms of the Homestead Act.

The works are widely distributed and have been built in each of the western states, from the Rocky Mountain region to the Pacific Coast. These states in alphabetic order, are: Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota Utah, Washington, and Wyoming. The irrigated land will extend into the state of Texas from works built into New Mexico and experimental construction has been undertaken in Oklahoma.

The works already completed or nearing completion furnish water for a little over one million acres and when finished the projects now in hand will supply nearly three times this area. The number of farms irrigated is, in round numbers, 14,000. There are now being operated nearly 5,000 miles of canal and the value of crops obtained from lands thus being served with water was over $13,000,000 in 1911. It is estimated that a population of very nearly 70,000 persons, exclusive of those in the cities and towns, is now dependent upon these works.

The act of Congress as originally passed was very broad in its provisions, and simply indicated the results to be attained. In the ten years which have elapsed since the passage of this act, a vast amount of executive detail has been developed, additional legislation upon minor matters added, and an organization built up competent to handle the widely scattered work. The wisdom of the act has been demonstrated by the success attained and the optimistic predictions of the framers of the act have been amply verified.

The work in many respects has been pioneer in character. The country in which the projects are constructed is sparsely settled, the structures themselves frequently remote from railways or other lines of communication, and it has been necessary for the employees of the Government to enter into many details which appear at first sight to be quite foreign to the object of the law. Thus it results that the operations being distant from the railways in some cases, it has been necessary to build these and as it was impossible to deny to the scanty population the conveniences of these railroads, it has been necessary to operate them upon a commercial basis.

One of the principal items for construction is Portland cement. In the case of the Roosevelt dam in Arizona, this was so far away from railroads, and conditions were such that it was found desirable for the Government to build and operate its own cement plant. Incidental to much of its work it has been necessary to operate commissaries, boarding houses, mercantile stores, hospitals, and enter into an infinite variety of matters which would not be necessary in an older country. It has been necessary to bring together hundreds of workmen and subsist them and their families in remote places, and thus has resulted the development of many enterprises carried on by the Government, which would not be necessary excepting under pioneer conditions.

From the standpoint of the chemical engineer, the most interesting of these operations are possibly those which relate to the development of water power in connection with the conservation of waters for use on the dry land and the employment of this power coincident with its use in irrigation. The storage of flood waters in the mountain valleys makes it practicable to control the flow of certain streams through a great part of the year, and the water in passing from the point of storage to that of use descends in many localities at such rapid rate as to furnish facilities for water power development.

In earlier decades water powers were used to a considerable extent at factories distributed throughout the mountain country. Later the inconvenience of going to the water power resulted in steam largely displacing it as the most important agency in manufactory. Then came the development of electrical transmission by which the water power could be brought to centers of population, and again water power came into prominence in industrial affairs. But one of the conditions of success with hydroelectric power is that of continuity of service day by day without intermission throughout the year. In the case of water stored for use in irrigation, the maximum demand comes during the hot period of summer or during winter. In the season when crops are not growing the water is not needed and should be stored. Thus we have an excess of water for power during the summer or crop season and little or no water available for power during the remaining months.

Under these conditions of summer supply only the water power obtained from works built for irrigation has relatively little value, especially in the ordinary uses of lighting, transportation, etc. But there have been found to be certain chemical industries where the time element is not very important. Thus it results that much of the water power which would otherwise be unavailable can be utilized for chemical manufacturing in connection with, but secondary to, the demands for irrigation.

One of the industries which it is hoped may be developed is that of the making of fertilizers by fixing the nitrogen of the air by means of the electric current developed from the waters stored for irrigation and released during the crop season. In all irrigated countries there is a great need for fertilizers. There is a popular fallacy that irrigation water brings all that is needed for the growing plant, but this is not true. Under intensive cultivation such as is possible by irrigation, there is great need for fertilizers. Very few, if any, of the natural waters, even though carrying considerable sediment, supply the nitrogenous matter needed by the crops.

In a less direct manner the operations of the Reclamation Act have interest to the manufacturing chemists of the country, in that through the conservation and use of the waste waters employed in the cultivation of the waste ground, there is developed a market or necessity for all of the articles which enter into the operations of daily life. The putting into the waste places of the country of a dense population of prosperous farmers results in a demand for manufactured products (including those from various applications of chemistry) to a degree unequaled by any other form of development. The soil when properly cultivated in the arid regions, where the sunshine occurs daily throughout the year, has a degree of productivity unknown elsewhere. Where intelligently handled the small farms yield a return which enables the owners to enjoy more than the average share of profit, and hence these farmers are not only producers of raw material, but the best and most reliable consumers of manufactured articles of any class of people.

When it is comprehended that the owners of these small farms would probably have been unable to secure homes in any other way and that the individuals are taken largely from the non-productive class and converted into producers of wealth from the soil, it will be appreciated that the action of the national Government in utilizing its resources in this manner is not only wise in adding to the prosperity, but to a certain degree is one of the best insurances of the continuity of national life. The owner of the small intensively cultivated farm is one of the most progressive of citizens and at the same time conservative so far as those things which affect the stability of the Government and of its institutions.

The operations under the terms of the Reclamation or Newlands Act are committed to the Secretary of the Interior. He has authorized the creation of an organization or bureau known as the Reclamation Service, at the head of which is a Director, reporting to the Secretary and responsible to him for the planning, initiation and conduct of details as authorized by the Secretary, The principal executive officer under the Director is a Chief Engineer, who in turn has 6 supervising engineers located at convenient points in the west, each supervising engineer being the local representative of the organization. The Director and Chief Engineer alternate in the Washington office and in the field, dividing or sharing the duties of the field and office work, the Director giving principal attention to the larger administrative matters and the Chief Engineer to the more purely technical details.

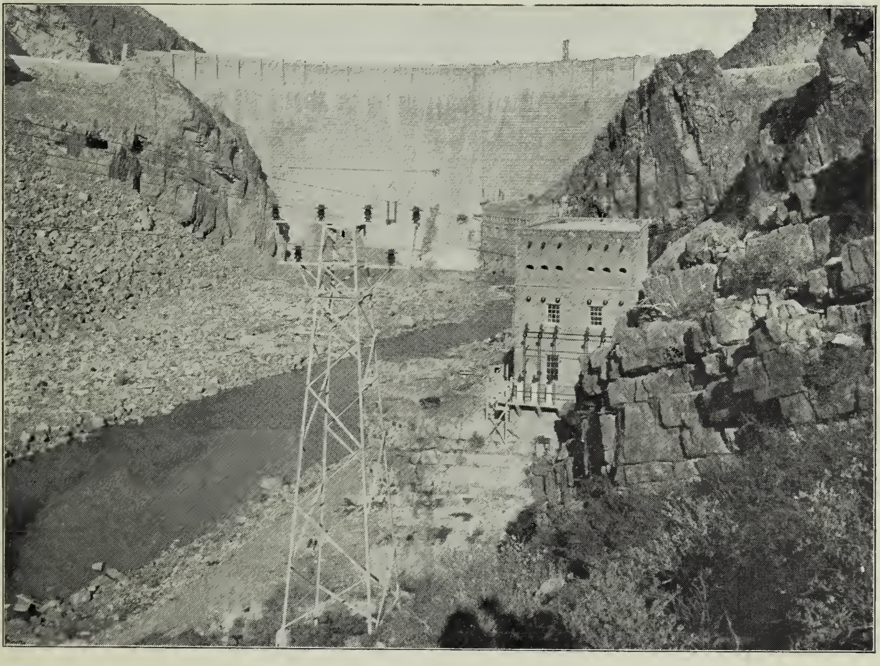
Each supervising engineer has charge of a number of projects located usually in different states. These projects cover considerable areas, being sometimes from 50 to 100 miles in length, and the project engineer or manager must spend his time largely in moving about over the project. Each separate feature is under the direction of a resident engineer or superintendent, who reports to the project manager. For example, during construction the project engineer has general charge, and if a large storage dam is being built perhaps 50 or 100 miles away, there is a resident engineer on the ground in immediate charge and another engaged in the building of the diversion dam, distributing canals, etc.

Each of these resident or constructing engineers and superintendents of construction has one or more engineering and technical assistants and each project is provided with a chief clerk, who supervises the bookkeeping, costkeeping and all the details of records and correspondence.

The Reclamation Service as a whole embraces about 1,500 persons appointed after competitive Civil Service examination, and employs from 5,000 to 7,000 laborers, the number varying from day to day according to the work in hand. Much of the work is done by contract, especially by a series of small contracts in which the work is divided up into items of such size and character as to be readily described and bid upon by experienced men. That is to say, instead of attempting to let a large amount of work in a single contract and to throw upon a single contractor the responsibility of many ramifying details, it has been found far more economical to subdivide the work, the Reclamation Service occupying the position itself of the principal contractor and apportioning the operations to what would otherwise be subcontractors. For example, in building distributing systems involving many miles of canal, these are subdivided into portions of a mile or two and over in length, so that the farmers may bid upon as much or little as desired and may thus earn the money needed to establish themselves on the land and pay to the Government the cost of water delivered to their farms.

In the construction of tunnels for conveying water and in the building of dams where the foundations are far beneath the surface, it has been found more economical and effective to do the work by Government forces than to endeavor to let it by contract. The risks involved are so great that the contractor must either bid in such a way as to afford him a large margin to cover contingencies, or if he bids too close and his bid is accepted,

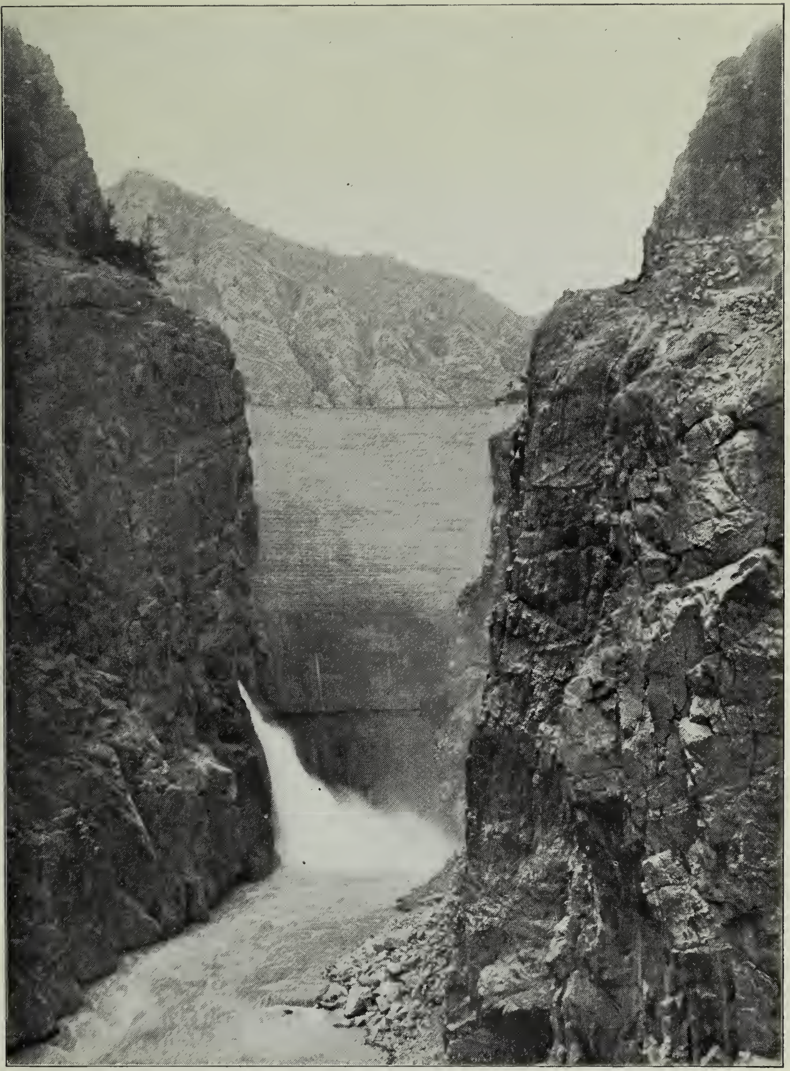
Pl. IA. Cement mill in foreground, contractor's camp in rear near Roosevelt dam site, Arizona.



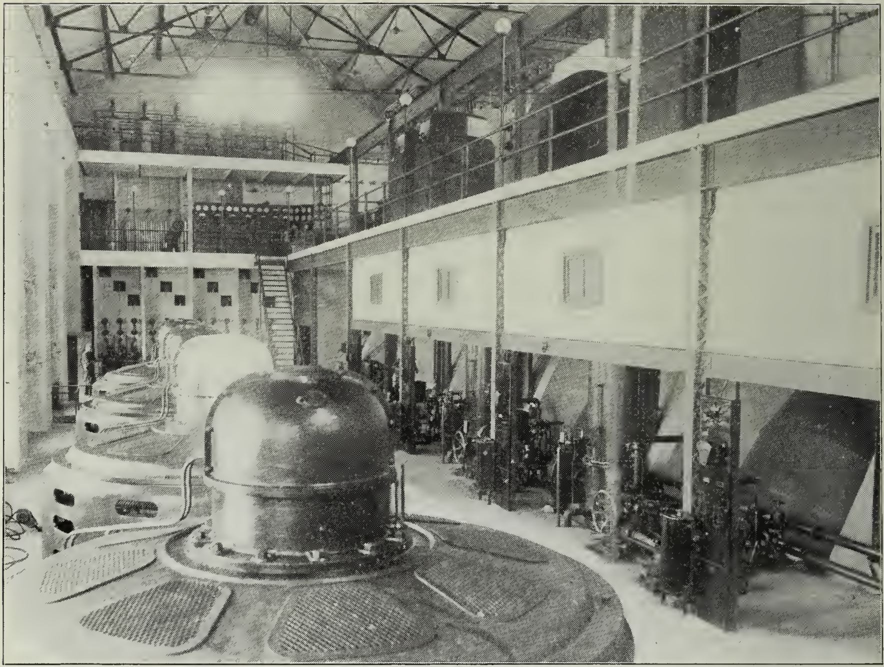
Pl. IB. Power plant utilizing stored water for generation of power at times when it is turned out of the reservoir for irrigation purposes.

Pl. IIA. Roosevelt dam, Arizona, view from above showing stored flood waters.

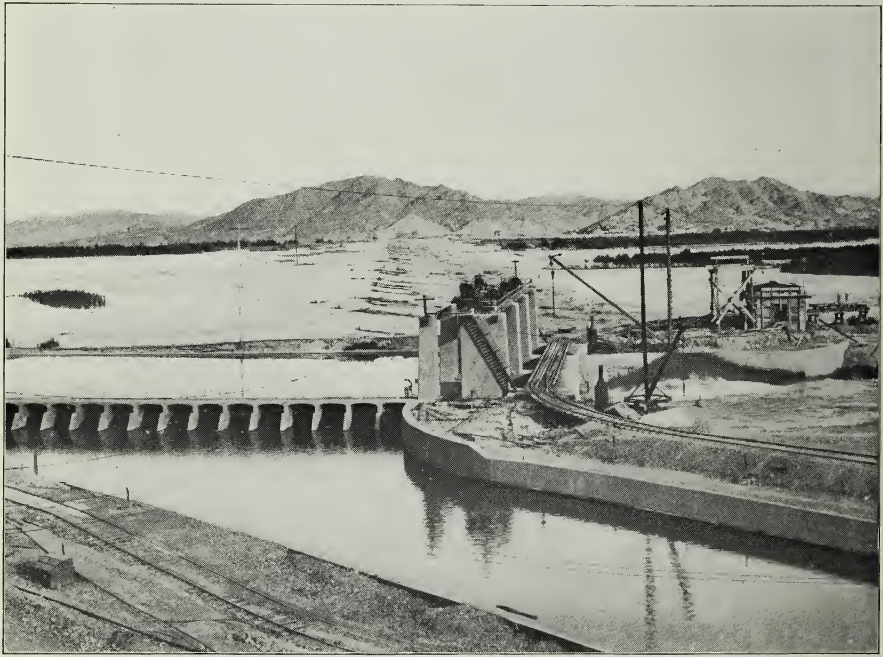
Pl. IIB. Jackson Lake dam at head of Snake River in Wyoming holding waste waters for use on desert lands in Southern Idaho.



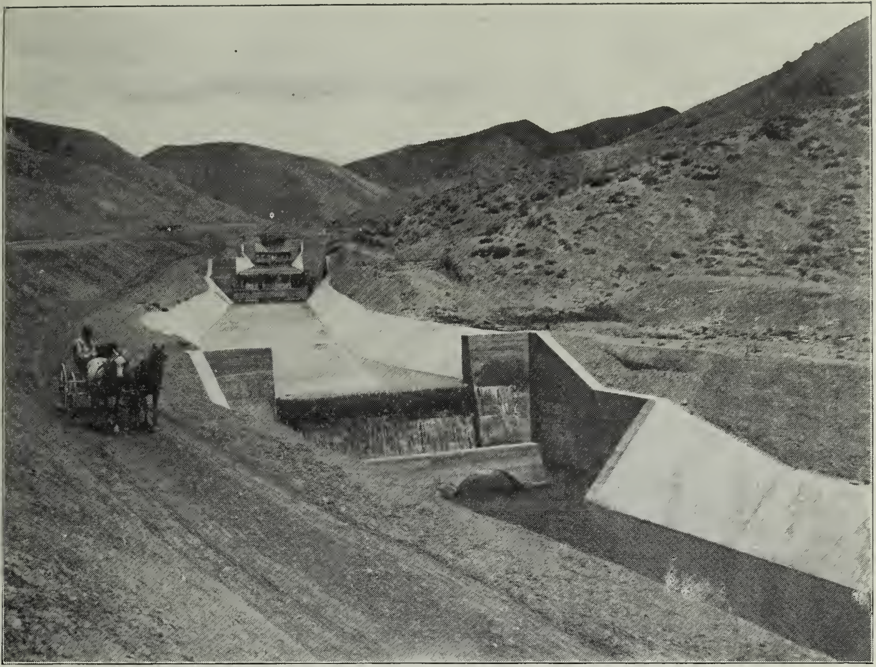
Pl. VIII. Shoshone dam, (highest in the world, 327 feet high) on Shoshone River east of Yellowstone Park, Wyo., for holding flood waters.



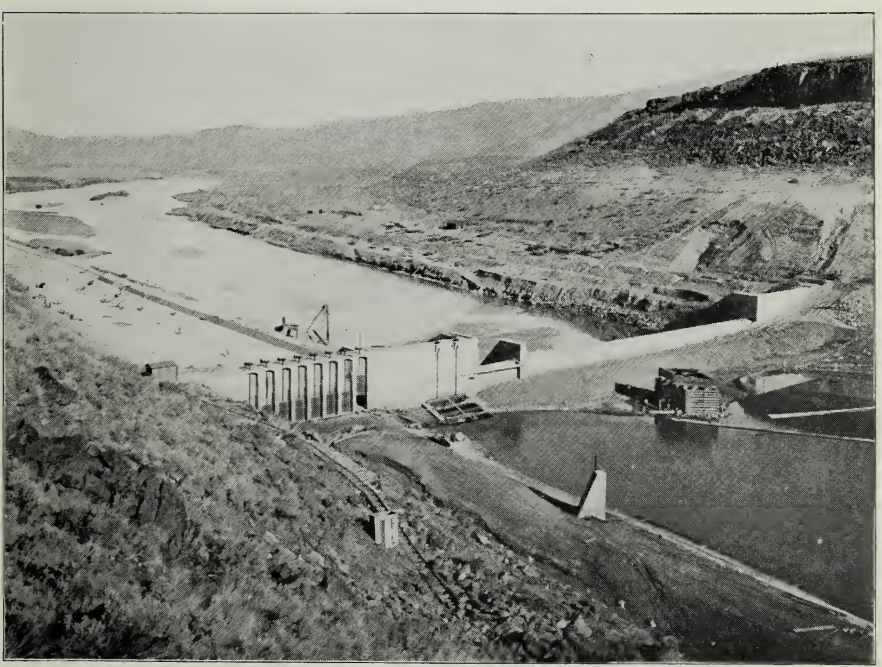
Pl. IIIA. Interior of power plant at Minidoka, Idaho, operated by waters controlled by irrigation works built for Minidoka project.



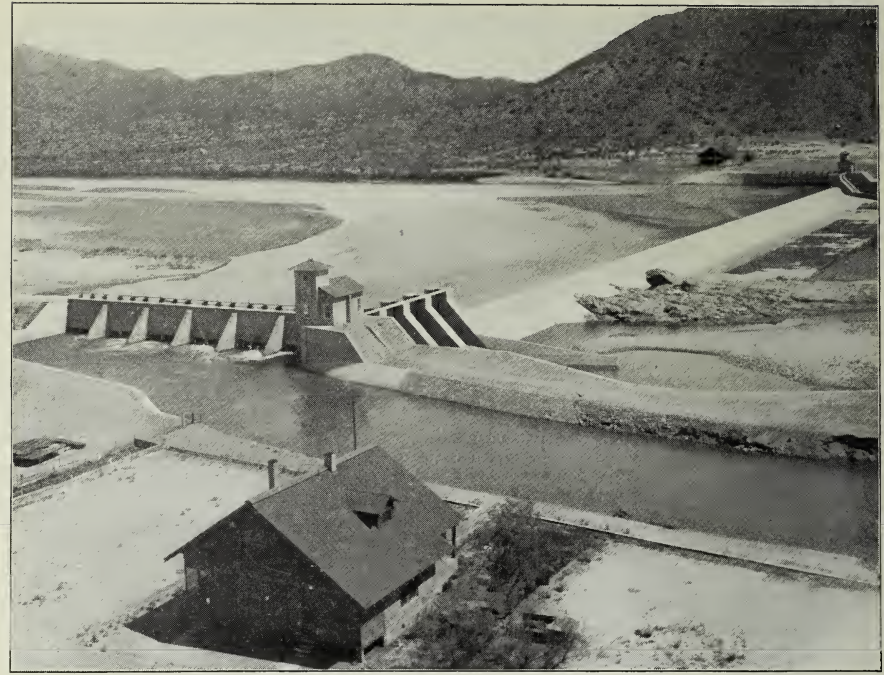
Pl. IIIB. Laguna dam on Colorado River looking from the California side easterly to the Arizona shore, dam is 4,000 feet long. In foreground is skimming device for taking out the less muddy waters.



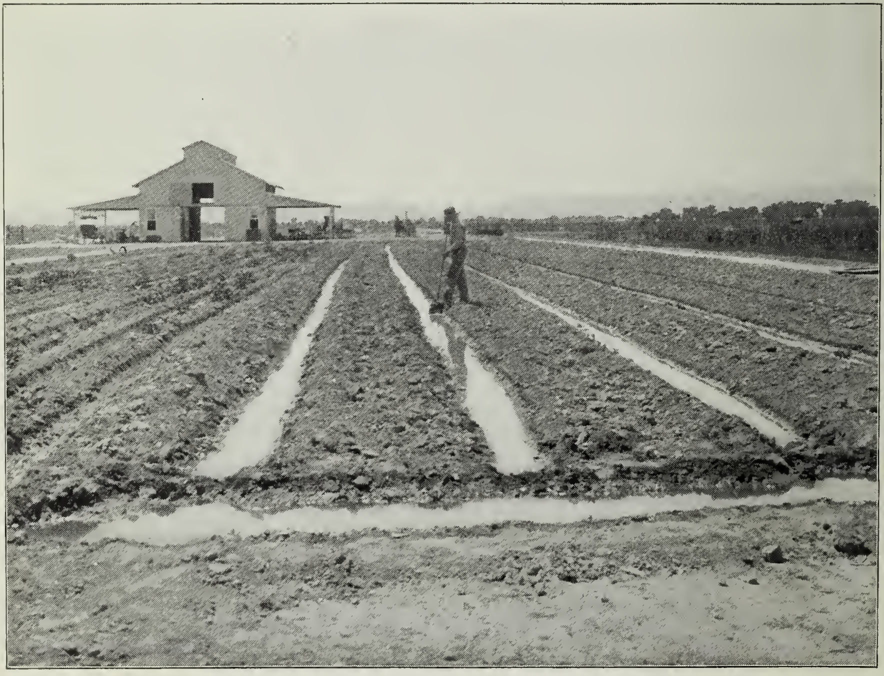
Pl. IVA. Drops on South Canal, Uncompahgre project, Colo., taking otherwise useless Gunnison River waters to Uncompahgre Valley; method of dropping these waters to the Valley.



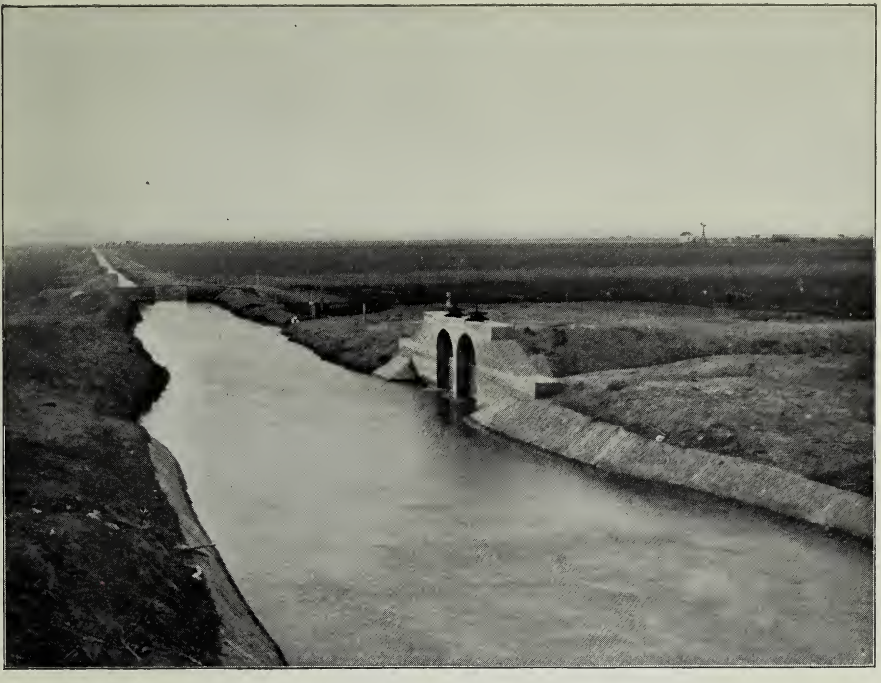
Pl. IVB. Dam on Boise River to divert flood waters into the storage reservoir. View at time when large canal is being lined with concrete and low water flow of the river is being diverted through lower sluices.



Pl. VA. Diverting dam on Salt River, Ariz., showing in foreground the head of the northside canal and on opposite bank the corresponding heading of south canal.



Pl. VB. Methods of distributing irrigation water to the desert lands.



Pl. VIA. Distributing canal and structures on North Platte project, Nebraska.

Pl. VIB. Stack of alfalfa grown upon land otherwise worthless, excepting for the use of waters conserved and distributed by the Government system.

the losses usually force him into bankruptcy with corresponding delay to the work and increase of ultimate cost to the Government. The confusion and litigation which has resulted from the failing contractors on pioneer work of this kind more than overbalances any possible saving by letting such work by contract.

In the ten years which have elapsed since the passage of the Reclamation Act, the organization of the Reclamation Service has been developed, many notable structures built and large experience gained in operations of this character. The work has been conducted with a high degree of economy and continual efforts have been and are being made to improve in every possible detail. As a result of the character of construction initiated by the Reclamation Service all companies or associations entering upon reclamation by private capital have been induced or forced by public opinion to adopt similar methods of construction and to substitute instead of temporary works of wood the more permanent structures of concrete and iron. The development of the country has been greatly stimulated and altho the Reclamation Service has not reclaimed and will not irrigate more than a portion of the irrigable area, yet the results attained by it have greatly encouraged and stimulated private and corporate efforts and served as a standard for them.

It may be said that the larger problems of organization and construction have been solved, altho continual improvements are being made. The most difficult period of the work, however, is now being entered upon, namely that of operation and maintenance of the completed works and especially of the dealings with the thousands of farmers and collection from them of the cost of the work.

While construction is under way and money is being spent by the Government, there is little criticism but when the time arrives that these expenditures must be recovered in small payments from the farmers, then arises a critical attitude and an attempt to ascertain whether it is not possible to avoid repaying to "rich Uncle Sam" the investments made on behalf of the hard-working farmers! This is perfectly natural because the public has been educated by gifts of seeds and beautifully illustrated publications to the belief that the generosity of Uncle

Sam is unbounded and that there is no limit to the expenditures that he may make.

In the case of the reclamation fund, however, there is a very definite limit. Any concession granted to one man or set of men in the nature of delay in repaying the expenditure means the depriving of another man or set of men of a corresponding benefit. It is this condition which is depended upon to bring about a true appreciation of the opportunities afforded by the Reclamation Act and a safeguard of the Reclamation fund, namely the needs of the man who has not yet obtained adequate water supp'y may be depended upon to force the man who has already obtained water to make payment for the benefits received.

The cost of water provided by the works built by the Government may be said to range in general from $30 to $40 per acre. In some cases it has been as low as $22 per acre, and in others as high as $93 per acre. Without the water the land is practically valueless. With an assured supply the land when properly cultivated will pay a good return on an investment of from one hundred to several hundred dollars per acre. The addition of the water allows the owner of the land practically to capitalize the sunshine, and altho the soil may not be of the best, yet with sunshine and water at the right time extraordinary crops may be produced, especially in the warmer parts of the arid region. Even in the northerly latitudes the crop production of forage is large enough to repay an investment of upwards of $50 per acre in obtaining water.

From the figures above given it might be assumed, and has been, that operations of this kind would afford wonderful opportunities for investment of private capital. There are, however, certain conditions which are not generally understood and have resulted in the past in depriving investors of the return of the money used in building irrigation works. The economic conditions have usually not been carefully studied in advance; generally the estimated cost of the completed system has been too small. While the engineers may have figured with considerable accuracy on certain structures, it has been found that the building of these necessary structures is only the beginning of the expenditure. The cost of promotion and of administration has frequently equaled that of engineering and construction proper; on top of this has usually been a lack of knowledge of water supply and of other conditions which have rendered many private enterprises unprofitable. The most difficult condition, however, has been that arising from the unforeseen delays and the impossibility of collecting promptly from the farmers the cost of the water. It has usually required years for them to subdue the soil and put it into highly productive condition. As a rule they have neglected to properly level and prepare it and the average crop production per acre has been ridiculously small at first as compared with the possibilities of the case.

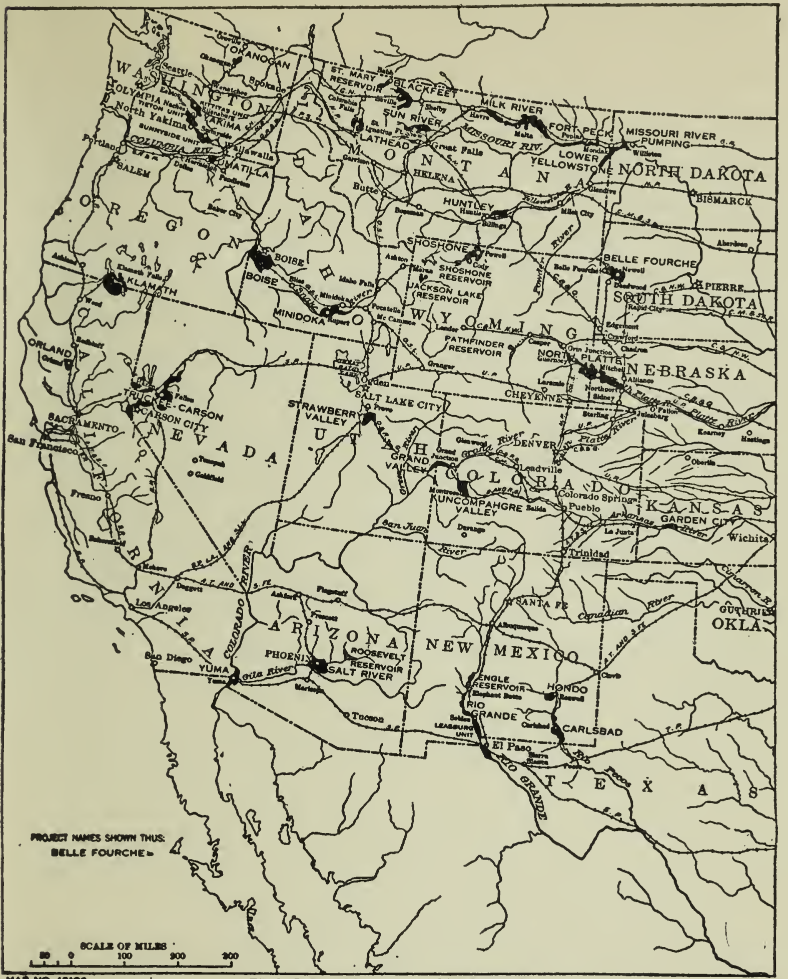
On every irrigated area there are usually to be found a number of persons who with skill and care have produced very large returns per acre, illustrating what might be done by their neighbors if all would exercise the same energy and follow the same methods. But the majority of the new comers do not do this at once and it requires many years of trial and the gradual elimination of the incompetent before the farmers, coming from all parts of the world, have acquired through individual experience the knowledge which enables them to produce highly profitable crops. Meantime the investors in these private works have been compelled to continue to operate and maintain them at large cost and have as a rule been unable to pay interest on their bonds, and have finally gone into bankruptcy during the time in which the farmers have learned how to irrigate successfully.

In the case of the work of the Government these delays, while injurious, are not as destructive as to private investors because the Government is not immediately dependent upon getting its money back or making large payments on interest on bonds. For this reason it is able to undertake and to carry through to successful completion enterprises which from their magnitude or intricacy would not be profitable to private capital.

The most serious of the complications which beset all enterprises of this kind are those which arise from the imperfections of the laws relating to the control of the waters in the streams. The distribution of these is under State authority and very few of the arid or semi-arid States have laws which are adequate to the conditions, most of the laws were patterned originally upon the common law practice of the humid states; the so-called "riparian rights," still lingering in portions of the arid West, practically forbid irrigation development. Even where the states have adopted the doctrine or theory of appropriation the practice has been so imperfect that the waters of most streams have been over appropriated to an extent many times that of the flood flow. The result is that in some of the states development is not only retarded but it has been ascertained that in some localities the amount spent in litigation exceeds that utilized in irrigation.

In the works built by the Government these matters of water rights are determined in advance of construction and on the basis of carefully conducted observations of river flow. Thus while it has been impracticable for private capital to delay to ascertain what are the conditions, it has usually been possible for the Government to select those localities where it is known that water is available and has not already been appropriated by others. For this reason the water rights obtained from the Government can be depended upon to actually yield water, while those purchased from private corporations have often been open to doubt.

Summing up the conditions, it may be said that the work of the Government in the conservation of waters and the use of these has not only stimulated private enterprise but has forced it to a high degree of attainment and has furnished a standard for construction and for adequacy of supply such as to materially improve the general conditions. It has used its resources in undertaking projects which otherwise could not have been handled, and in so doing has added materially to the wealth and prosperity of the nation and particularly of the sparsely settled states, not enriching any one small group of men, but enabling men of relatively small means to acquire homes and affording them an opportunity to become land owning citizens.



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PRINCIPAL IRRIGATION PROJECTS
IN THE WESTERN UNITED STATES

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